Medical Science

25(116), October, 2021

The effect of Iranian and foreign mouthwashes on discoloration of Fuji II LC glass ionomer (in vitro)

Shapoor Naziri[1], **Parisa Sarikhani**[2]✉, **Negin Nasoohi**[1], **Fateme Zarouni**[2]

To Cite:
Naziri S, Sarikhani P, Nasoohi N, Zarouni F. The effect of Iranian and foreign mouthwashes on discoloration of Fuji II LC glass ionomer (in vitro). Medical Science, 2021, 25(116), 2539-2545

Author Affiliation:
[1]Department of Operative Dentistry, Islamic Azad University of Medical Sciences, Dental Branch, Tehran, Iran
[2]Department of pediatric, School of Dentistry, Lorestan University of Medical Sciences, Khorramabad, Iran

✉**Corresponding author**
Department of pediatric, School of Dentistry, Lorestan University of Medical Sciences,
Khorramabad, Iran

Peer-Review History
Received: 5 September 2021
Reviewed & Revised: 6/September/2021 to 26/September/2021
Accepted: 28 September 2021
Published: September 2021

Peer-review Method
External peer-review was done through double-blind method.

ABSTRACT

Introduction & Objective: GIC was first introduced in 1972 by Willson and Kent. It consists of a water-soluble polyacrylic acid and fluoroaluminosilicate glass. When the silicate powder and polymeric liquid are mixed, an acid-base reaction takes place. They had an ion-leachable micro fluoroaluminosilicate glass filler context. To avoid dissolution, phosphoric acid along with carboxylic acid polymer were substituted for polycarboxylate zinc materials Discoloration of cosmetic restorative materials following application of chlorhexidine mouthwash is one of the most important factors influencing the success of restoration. Discoloration of glass ionomer restorations can cause patient dissatisfaction and lead to treatment failure. This study tended to investigate the effect of two types of chlorhexidine mouthwash on discoloration of glass ionomer by spectrophotometry. *Materials & Methods:* In this experimental study, 15 disc-shaped specimens with a diameter of 10 mm and a thickness of 2 mm were taken from Fuji II LC glass ionomer. The specimens were divided into three groups of 5 for storage in Iranian chlorhexidine mouthwashes 0.12% and foreign Kin gingival and distilled water. The specimens were immersed in the solutions for 12 h. Colorimetry of the specimens was performed by spectrophotometer before and after placing in the solutions. The results were evaluated by ANOVA, Repeated measured, Kruskal-Wallis, Smirnov-Kolmogrov tests. *Results:* Discoloration rate of glass ionomeric specimens after placement in both types of mouthwash was significant ($P>0.05$) and was not clinically acceptable ($\Delta E \geq 3.3$). There was also no significant difference in discoloration between Iranian and foreign chlorhexidine groups ($P = 0.0001$). *Conclusion:* Application of both Iranian and foreign chlorhexidine mouthwashes is not clinically acceptable.

Keywords: discoloration, chlorhexidine mouthwash, glass ionomer, tooth-colored restorative materials.

1. INTRODUCTION

Glass ionomers were introduced in 1972 by Kent and Willson to dental profession (Kerby & Knobloch, 1992), in which silicate and zinc

polycarboxylate were mixed together to obtain the desired properties of both. They had an ion-leachable microfluoro aluminosilicate glass filler context. To avoid dissolution, phosphoric acids along with carboxylic acid polymer were substituted for polycarboxylate zinc materials. These materials are in powder-liquid form that needs to be mixed. Discoloration of cosmetic restorative materials, including glass ionomer restorations following application of mouthwashes, is always one of the concerns of the dental community. Discoloration of these restorations is one of the common reasons for their replacement, which causes concern to the patient and the dentist, as well as spending a lot of time and money (Mutlu-Sagesen et al., 2005). Important external and internal factors affect discoloration of restorative materials of the same color. Exterior discoloration of restorations may be due to persistence of pigments resulting from consumption of beverages, diet, and long-term application of various mouthwashes in plaques or pellicle (Um & Ruyter, 1991). Concentration of mouthwash and method of application and number of applicationsas well as type of glass ionomer applied affect the surface quality of the restoration and color stability of the restoration (Stober et al., 2001). A new type of chlorhexidine mouthwash called Kin Gingival (made by labratorios kin, Spain) was introduced into the market, which according to its manufacturer, not only has beneficial effects of chlorhexidine, but also solves the problem of discoloration in cosmetic restorative materials such as glass ionomers after consumption (Lee et al., 2000).

Currently, chlorhexidine digluconate is widely used as a mouthwash due to its limited side effects and absence of toxic and systemic side effects and significant antimicrobial effects of this mouthwash, and its application with scaling and oral surgery is often recommended by dentists (Rölla & Melsen, 1975; Shah et al., 2019; Kandaswamy et al., 2018). Kin Gingival mouthwash is a good treatment for gum diseases and periodontal disorders and its ingredients include 0.12 g chlorhexidine digluconate, 0.05 g sodium fluoride and 0.06 g sodium saccharin. The manufacturer recommends applying 15 ml twice a day, morning and night. Its effects include discoloration of teeth and restorations in long-term use and concomitant application with tobacco, foods and beverages such as coffee; this discoloration is not permanent and can be corrected by the dentist (Al-Mahmood & Sabea, 2021).

So far, notable research has been done to investigate the effect of chlorhexidine mouthwashes on discoloration of composite types (Celik et al., 2008; Al-Hyali & AL-Azzawi, 2010). However, little research has been done on the effect of chlorhexidine mouthwashes on glass ionomer discoloration (Lee & Powers, 2007; Tian et al., 2012). Considering the information gap in this field, we decided to conduct the present study to investigate the effect of Iranian and foreign chlorhexidine on discoloration of glass ionomer in restoration department of the Islamic Azad University of Tehran in 2013.

2. MATERIALS AND METHODS

This study was performed experimentally in vitro. The study tended to determine the effect of Iranian and foreign mouthwashes on discoloration of LC Fuji II glass ionomer and compare it with the control group in dentistry department of Islamic Azad University of Tehran in 2018-2019. The statistical population included Fuji II LC glass ionomer disks (Ethical code: IR.IAU.DENTAL.REC.1392.065). Based on previous studies and consultation with a statistician, 5 specimens (15 specimens in total) were examined in each group. The glass ionomer specimens were taken based on objective and placement in case and control media was done randomly. After determining the rate of discoloration in the specimens, data were recorded in an information form.

This study was performed on 15 specimens of Fuji II LC glass ionomer, A2 color. The specimens were randomly assigned to three groups. Thus, 5 specimens were assigned to control group (in distilled water at 37°C) and 10 specimens were assigned to case group (two groups of 5, A and B). To make 15 Fuji II LC glass ionomer specimens, a 2 mm thick stainless-steel plate in which a circle with 10 mm diameter was removed was produced as the generator. For each glass ionomer specimen, the material was prepared with powder-liquid ratio and mixing method recommended by the manufacturer. A perfectly flat glass slab was then placed under the generator and some of the glass ionomer was filled into the generator by a plastic instrument. Another 1 mm thick glass slide was placed on it and pressed firmly. The head of the coltolux 2.5 light cure device with a light intensity of 400 mW/cm^2 was placed exactly on the glass slide and was illuminated from above and below for 20 s; that is, glass ionomer specimens collectively were exposed to light for 40 s. The specimens were then placed for 24 h in 37°C water (set by incubator) in a dark medium to complete polymerization. The specimens were polished similarly with sufficient accuracy by polishing discs (3M ESPE-USA) sof-lex, from rough to soft with water; so that the surface of all specimens was completely smooth and no bubbles and porosities remained on the surface of the glass ionomer. Then, the specimens were randomly divided into 3 groups of 5, A, B, C, and primary color was measured on them by a spectrophotometer (color-eye 7000A, Gretag Mecbeth Instrument Crop, NewWindsor, NY, USA) with a standard white background according to the CIE Lab system. At this stage, the data was recorded in information form No. 1 and delivered to the researcher. To re-measure discoloration of the discs, the recorder used the information for No. 2 and did not have access to previous results. To measure the final discoloration, 3 media were considered for this study and immersion of specimens:

Media A: 5 specimens of Fuji II LC glass ionomer were taken and placed in 0.12% Kin Gingival mouthwash (labratorios kin, Spain) for 12 h.

Media B: 5 other specimens were placed in 0.12% chlorhexidine gluconate mouthwash (Hexodine, Donyaye Behdasht Company, Tehran, Iran). All 5 specimens were immersed in the mouthwash.

Media C: 5 other specimens of Fuji II LC glass ionomer were also placed in 37℃ distilled water (set by incubator).

Finally, all specimens were shaken 10 times in a container containing distilled water for washing and then rinsed under a stream of distilled water for 5 s. Color of the specimens was then measured again by spectrophotometer with a standard white background. The device calculated indices L, a and b according to the CIE Lab systemand ΔE was calculated and reported by the formula $\Delta E = [(\Delta a)^2 + (\Delta b)^2 + (\Delta L)^2]^{1/2}$. Statistical methods included ANOVA, Repeated measured, Kruskal-Wallis, Smirnov-Kolmogorov tests.

3. RESULTS

In this study, which was performed experimentally on 15 glass ionomeric disks, the rate of discoloration of glass ionomeric disks was investigated in Iranian and foreign chlorhexidine media. Indices a, b and L were measured in case and control groups before and after exposure to mouthwash and water (Tables 1 to 3 and Figures 1 to 3). Δa, Δb and Δl were also calculated in different media (Table 4). According to analysis of variance, the difference in ΔE was statistically significant between three solutions used (P-value = 0.003) (Table 4). Each of the 3 solutions also showed discoloration in both baseline and 12 hours later. In Iranian and foreign chlorhexidine solutions, this difference was significant in both cases (P-value = 0.0001). However, in distilled water, discoloration rate was not significant (P-value = 0.845; Table 5). Δa was statistically significant in all three solutions (P-value<0.05). Δb was significant only in foreign chlorhexidine solution (P-value=0.031). Δl was statistically significant in both Iranian and foreign chlorhexidine solutions (P-value<0.05) (Table 6).

Table 1 L, a and b values after exposure to kin gingival by specimens

discoloration	baseline			Kin gingival		
specimen	b	a	l	B	A	L
1	6.91	0.53	63.27	5.056	1.596	60.121
2	7.68	0.39	63.67	4.028	0.973	61.190
3	7.20	0.56	64.55	5.546	1.102	61.016
4	7.52	0.39	63.69	5.939	1.455	59.765
5	6.54	-0.09	64.48	6.321	1.067	61.143

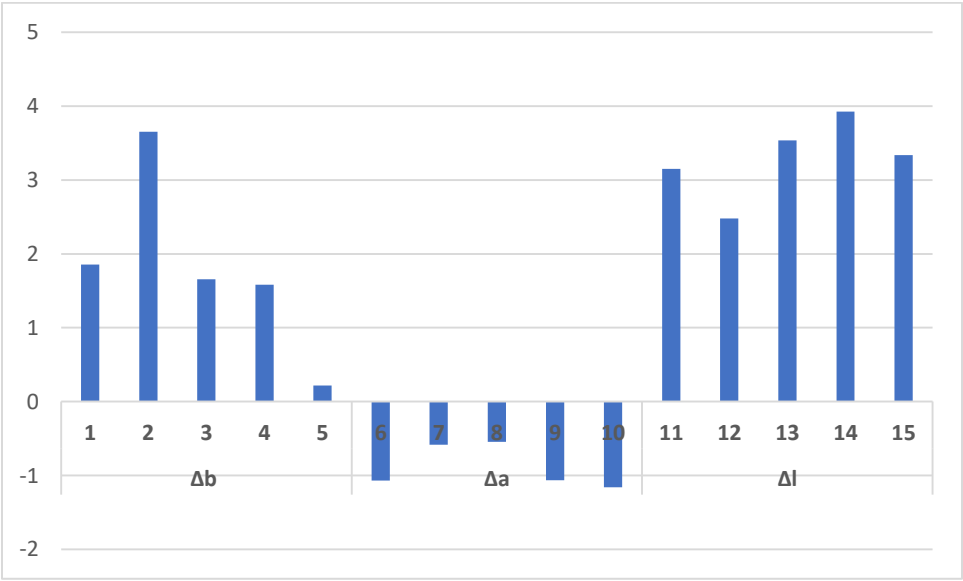

Figure 1 Δ values after exposure to kin gingival by specimens

Table 2 L, a and b values after exposure to 0.12% Chlorhexidine by specimens

discoloration	baseline			0.12% Chlorhexidine		
specimen	b	a	l	B	A	L
1	6.33	0.00	63.48	5.764	0.580	59.112
2	7.75	-0.19	63.81	4.295	0.385	60.404
3	7.32	0.34	65.42	4.593	0.519	61.699
4	6.85	-0.18	65.54	6.006	0.247	60.558
5	5.10	-0.77	65.09	6.791	0.695	61.301

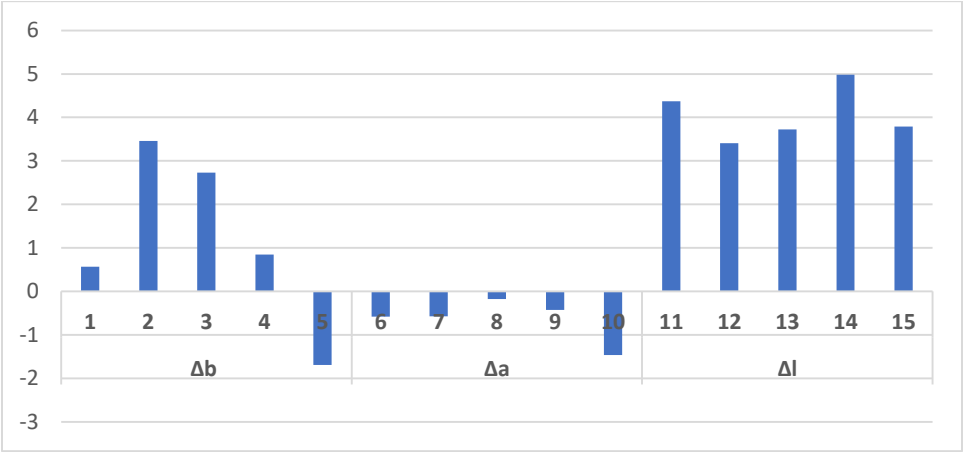

Figure 2 Δ values after exposure to 0.12% Chlorhexidine by specimens

Table 3 L, a and b values after exposure to distilled water by specimens

discoloration	baseline			distilled water		
specimen	b	a	l	B	A	L
1	6.27	0.95	64.42	5.958	0.721	64.779
2	7.95	0.50	63.02	7.754	0.370	63.420
3	6.30	0.48	62.32	6.037	0.262	61.939
4	7.57	0.75	61.92	7.549	1.041	62.408
5	6.25	0.85	62.84	6.477	0.969	62.360

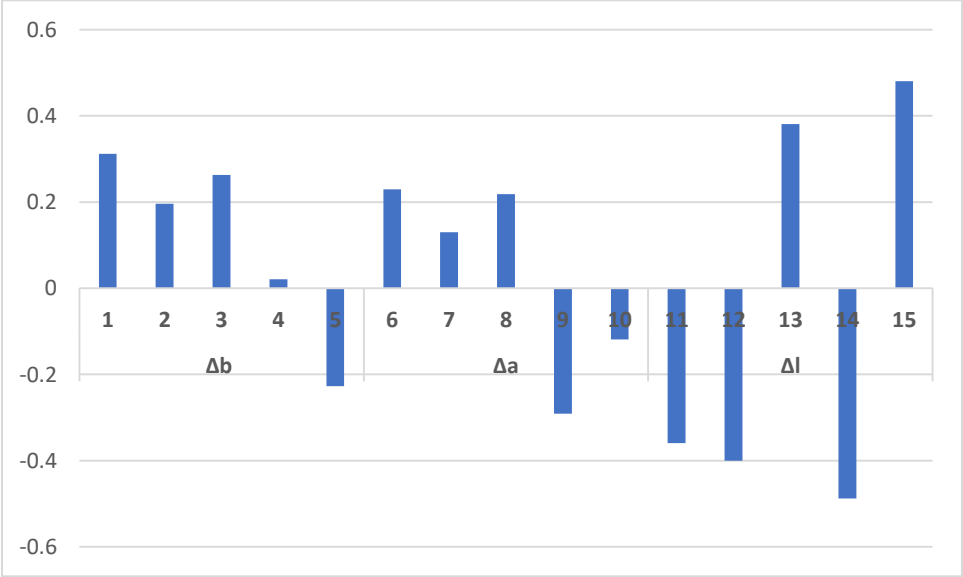

Figure 3 Δ values after exposure to distilled water by specimens

Table 4 comparison of discoloration by medium

discoloration medium	E∆ mean±SD	P-Value
Kingingival	3.43±0.465	0.003
Chlorhexidine 0.12%	4.144±0.583	
distilled water	0.056±0.600	

Table 5 comparison of discoloration of Fuji II LC glass ionomer by groups

time medium	baseline	12h	ΔE	P-value
Kin gingival	64.334±0.537	60.904±0.640	3.43±0.465	0.0001
Chlorhexidine 0.12%	65.018±0.943	60.874±0.989	4.144±0.583	0.0001
distilled water	63.426±0.853	63.370±1.107	0.056±0.600	0.845
P-value	0.026	0.001	0.003	

Table 6 statistics of variations in the variables by medium

discoloration medium	mean±SD		
	Δa	Δb	Δl
Kingingival	-0.884±0.398	1.79±1.223	3.484±0.714
P-value	0.003	0.031	0.0001
Chlorhexidine 0.12%	-0.648±0.487	1.18±2.017	3.854±0.656
P-value	0.041	0.261	0.0001
distilled water	-0.206±0.071	0.112±0.220	-0.278±0.373
P-value	0.003	0.319	0.121

4. DISCUSSION

This study, which was performed to investigate the effect of two types of chlorhexidine mouthwash on discoloration rate of glass ionomer, showed that discoloration rate is not clinically acceptable after 12 hours of exposure to glass inomer discs in mouthwash (ΔE≥3.3). Two types of mouthwash were used in this study; Iranian chlorhexidine 0.12% available in the market and Chlorhexidine 0.12% Kin gingival made in Spain, which according to its manufacturer has no emollient effect on resin restorative materials and discoloration. These two types of mouthwash were compared in terms of discoloration on glass ionomeric discs. A similar study was conducted by Yong-Keun Lee et al., (2005) on discoloration of V-class restorative materials. Four types of V-class restorative materials (including glass ionomer modified glass ionomer resin, compomer and flow composite) were exposed to 0.2% chlorhexidine for 24 h. The rate of discoloration was not clinically acceptable only in the case of modified glass ionomer resin (ΔE≥3.3). The rate of glass ionomer discoloration in this study was clinically acceptable, which is inconsistent with the results obtained in the present study (ΔE≤3.3). This study and the present study used a spectrophotometer for colorimetry, which has a high accuracy (Lee & Powers, 2007). Cigdem Celick et al., (2008) studied color stability of tooth-colored restorations exposed to three mouthwashes 0.2% chlorhexidine, 10% listerine, and Oral-B and showed that all specimens had discoloration after 12 hours of exposure to these media; however, discoloration was not significantly different in any of these media. They used acalorimeter for colorimetry, which does not have the accuracy of a spectrophotometer (the device used in the present study) (Celik et al., 2008). A study was conducted in 2010 by Nagham A.Al-Hyali on the effect of three types of mouthwash, Chlorhexidine 0.2%, Listerine, Oral-B on stability of two types of Nanofilled and Packable composites. Each specimen was immersed in solutions for 24 h. The results showed that discoloration by chlorhexidine mouthwash was noticeable only on the nanofilled composite. This study and the present study both used chlorhexidine mouthwash but with different concentrations. Fucong Tian et al., (2012) examined the effect of distilled water, cola, red wine and coffee on discoloration of five types of glass ionomers containing pre-cured composites (giomer). The specimens were immersed in these solutions for 7 days. The results showed that the highest discoloration was related to coffee and the lowest discoloration was related to distill water. In this study and the present study, a spectrophotometer was used for colorimetry, which has a high accuracy (Tian et al., 2012).

In this study, colorimetry was performed by spectrophotometer based on CIE Lab system, which has high accuracy and is currently preferred over other colorimetric methods (Van Strydonck et al., 2004; Lee et al., 2000). The number of specimens, considering the novelty of the subject and its position as a basis for further research and according to the statistical consultant, was set at 15 with dimensions of 2 × 10 mm to be colorimetrically measured in a spectrophotometer. For proper curing, specimens with an intensity of 400 mw/cm^2 were cured once from the upper surface and once from the lower surface for a total of 40 seconds. In all of these specimens, this was performed uniformly. Duration of exposure ofspecimens to the mouthwashes were the same (12 hours), so that if each person consumes mouthwash on average once a day for two minutes, then every 12 hours of exposure to mouthwash is equivalent to one year of application. Since application of mouthwash, according to the latest studies, its application does not cause problems for up to a year because it does not change the normal flora of the mouth (Eick et al., 2011). Accordingly, the exposure duration was set at 12 hours (Celik et al., 2008; Rölla & Melsen, 1975). To bring the research conditions closer to the oral environment, a temperature of 37°C was selected and the samples were polished after polymerization, and then initial colorimetry was performed. Despite claims by the Spanish manufacturer of Kin gingival, the resulting discoloration was expected to be less than the Iranian type. However, the results of the present study did not confirm this claim and showed that the discoloration caused by exposure of the specimens to the mouthwashes is not much different.

5. CONCLUSION

It is suggested to investigate interior discoloration of glass ionomers. Finally, the results showed that application of both Iranian and foreign chlorhexidine mouthwashes lead to discoloration of glass ionomer and are not clinically acceptable ($\Delta E \geq 3.3$). The present study was performed only on ionomeric glass of the same color; thus, it is suggested to perform similar studies on other colors and other types of glass ionomer. Moreover, polishing was not performed after exposure to mouthwashes, because the purpose of this study was only to investigate exterior discoloration following the use of mouthwashes.

Acknowledgement

We thank the participiants who were all contributing samples tothe study. And we also thank from azad Tehran University of dental branch.

Author contributions

This study was designed and coordinated by Dr. Parisa Sarikhani and Dr. Shapoor Naziri. Dr. Neginnasouhi and Dr. Parisa Sarikhani provide conceptual and technical guidance for all aspect of the project. Dr. Fateme Zarouni performed and analyzed the data. The manuscript was written by Dr. Parisa Sarikhani and commented on by all authors.

Ethical approval

The study was approved by Medical Etical Committee of Azad university of Iran. Ethical approval code: IR.IAU.DENTAL.REC.1392.065.

Conflicts of interest

The authors declare that they have no conflict of interest.

Funding

This study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Al-Hyali NA, AL-Azzawi HJ. Effect of three types of mouth rinses and human saliva on color stability of packable and nanocomposite resins (in vitro study). Journal of Baghdad college of dentistry 2010;22(3);8-12
2. Al-Mahmood S, Sabea DW. Comparative Evaluation of the Effectiveness of 40% Miswak Mouthwash and 0.12% Chlorhexidine Mouthwash in Treating Gingivitis: A Blinded, Randomised Clinical Trial. Oral Health Prev Dent 2021; 19:229-33.

3. Celik C, Yuzugullu B, Erkut S, Yamanel K. Effects of mouth rinses on color stability of resin composites. Eur J Dent 2008; 2:247-53.
4. Eick S, Goltz S, Nietzsche S, Jentsch H, Pfister W. Efficacy of chlorhexidine digluconate--containing formulations and other mouthrinses against periodontopathogenic microorganisms. Quintessence Int 2011; 42.
5. Kandaswamy SK, Sharath A, Priya PG. Comparison of the effectiveness of probiotic, chlorhexidine-based mouthwashes, and oil pulling therapy on plaque accumulation and gingival inflammation in 10-to 12-year-old schoolchildren: a randomized controlled trial. Int J ClinPediatr Dent 2018; 11:66.
6. Kerby RE, Knobloch L. Strength characteristics of glass-ionomer cements. Oper Dent 1992; 17:170-4.
7. Lee YK, El Zawahry M, Noaman KM, Powers JM. Effect of mouthwash and accelerated aging on the color stability of esthetic restorative materials. Am J Dent 2000; 13:159-61.
8. Lee YK, Powers JM. Combined effect of staining substances on the discoloration of esthetic Class V dental restorative materials. J Mater Sci Mater Med 2007; 18:165-70.
9. Mutlu-Sagesen L, Ergün G, ÖZKAN Y, Semiz M. Color stability of a dental composite after immersion in various media. Dent Mater J 2005; 24:382-90.
10. Rölla G, Melsen B. On the mechanism of the plaque inhibition by chlorhexidine. J Dent Res 1975; 54:57-62.
11. Shah SS, Nambiar S, Kamath D, Suman E, Unnikrishnan B, Desai A, Mahajan S, Dhawan KK. Comparative evaluation of plaque inhibitory and antimicrobial efficacy of probiotic and chlorhexidine oral rinses in orthodontic patients: a randomized clinical trial. Int J Dent 2019; 2019.
12. Stober T, Gilde H, Lenz P. Color stability of highly filled composite resin materials for facings. Dent Mater 2001; 17:87-94.
13. Tian F, Yap AU, Wang X, Gao X. Effect of staining solutions on color of pre-reacted glass-ionomer containing composites. Dent Mater J 2012; 31:384-8.
14. Um CM, Ruyter I. Staining of resin-based veneering materials with coffee and tea. Quintessence Int 1991; 22.
15. Van Strydonck DA, Scalé S, Timmerman MF, Van der Velden U, Van der Weijden GA. Influence of a SLS-containing dentifrice on the anti-plaque efficacy of a chlorhexidine mouthrinse. J Clin Periodontol 2004; 31:219-22.